

[124.3 (3.9)] compared to the non-Mn miners [113.1 (5.1)] ($p = 0.11$). Mn miners had lower mean (standard error) neuron density in the caudate [203.1(24.9) cells per high powered field (hpf)] compared to non-Mn miners [276.9 (22.3) cells per hpf] ($p = 0.016$). Mn miners also had lower astrocyte density in the caudate [181 (22.0) cells per hpf] and putamen [225.6 (28.5) cells per hpf] than non Mn miners [caudate 252.9 (19.6) cells per hpf and putamen 300.9 (25.4) cells per hpf] ($p = 0.011$ and $p = 0.024$, respectively). There were no significant differences in microglial cell density or in astrocyte, microglia or neuron cell counts in the globus pallidus between the two groups. There were no HIV-defining pathologies and no microglial nodules in any of the miners.

Conclusions This study demonstrates that chronic Mn exposure is associated with selective toxicity to striatal astrocytes and caudate neurons. We speculate that the initial neurotoxic injury in humans with chronic Mn exposure involves the astrocytes and that neuronal injury may be secondary to loss of astrocytes.

233 THREATS AND VIOLENCE AT THE WORKPLACE AND THE RISK OF DEVELOPING ANXIETY SYMPTOMS AND DEPRESSION

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Objectives Workplace threats and violence are common within certain professions. In the European countries, 5% of workers report having been subjected to violence. The health consequences are both physical and mental. This study analyses if repeated threats and violence or serious violence may lead to an increased risk of anxiety symptoms and depression.

Methods In 2007 and 2009 we examined 3224 civil servants employed in hospitals, schools, social centres etc. Exposure at baseline was self-reported number of times the last 12 months subjected to threats or non-serious physical violence or to mobility- or life-threatening violence. In 2007 and 2009, anxiety symptoms were scored (range 0–4) with the Symptom Check List and clinical depression with a psychiatric interview (SCAN). Cases of anxiety symptoms (score >2) and clinical depression at baseline were excluded. We used logistic regression analyses with estimates adjusted for potential confounders.

Results In 2007, 1079 (34%) reported that they had been subjected to threats or non-serious physical violence 1–5 times the last year and 170 (5%) more than 5 times. Fifty-nine (2%) had been subjected to mobility- or life-threatening violence. 173 developed symptoms of anxiety and 62 clinical depression. The adjusted odds ratios (ORs) for incident anxiety symptoms because of threats or non-serious violence 1–5 times were 1.69 (95% confidence interval 1.18–2.42) and more than 5 times 2.53 (1.34–4.77). The corresponding ORs for incident clinical depression were 1.32 (0.73–2.38) and 1.85 (0.71–4.83), respectively. There were too few cases among the exposed to analyse for the effect of mobility- or life-threatening violence.

Conclusions Exposure to threats and non-serious violence predicted anxiety symptoms. The risk increased with increasing number of episodes. The same pattern was found for depression though not significant. The results indicate the importance of considering the less serious but more frequent episodes when planning prevention.

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234 CHARACTERISATION OF WORK TASKS AND EXPOSURES TO CLEANING AND DISINFECTING CHEMICALS IN HEALTHCARE OCCUPATIONS

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Objectives Cleaning and disinfecting products have been identified as important risk factors for asthma, and are used extensively in healthcare; however, quantitative measurements of these etiologic agents are not well characterized. The objective of this study was to characterize personal exposure to cleaning and disinfecting compounds and quantify the frequency and duration of cleaning tasks performed in healthcare occupations.

Methods Exposure assessments were conducted for volatile organic compounds (VOCs) at 5 hospitals targeting 13 healthcare occupations. A wide range of specific VOCs ($n = 15$) were quantified and an additional 97 VOCs were identified but not quantified.

Results The geometric mean (GM) concentrations for total VOCs were highest among nursing assistants, licensed practical nurses and medical equipment preparers (GM range: 4367–3809 ppb), followed by respiratory therapists, pharmacy technicians, registered nurses, floor strippers/waxers, dental assistants and housekeepers (GM range: 2119–1501 ppb); the geometric standard deviations (GSD) varied from 1.8 to 7.5 across occupations. The GM and GSD of specific VOCs were also variable across occupations. The average amount of time per day spent on cleaning tasks using cleaning and disinfecting products also varied by occupation with medical equipment preparers, housekeepers, floor strippers/waxers and licensed practical nurses spending the most time (range: 165–110 minutes/day), followed by endoscopy technicians and dental assistants (range: 70–60 minutes/day); the remaining occupations spent on average <15 minutes/day on cleaning tasks.

Conclusions The chemical agents, levels of total and specific VOCs, and cleaning-task durations varied between- and within-occupations indicating that task may be an important exposure determinant.

235 AIRBORNE AND INTERNAL EXPOSURE TO CHROMIUM AMONG WELDERS

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Objectives The objective of this analysis was to investigate levels and determinants of exposure to respirable and urinary

chromium (CrR, CrU), and chromium in whole blood and in erythrocytes (CrBl, CrEry) in welders.

Methods Respirable welding fume was collected in 241 welders during a working shift. Blood samples and spot urine samples were collected after the working shift. The content of CrR in the welding fume was determined using inductively coupled plasma mass spectrometry. CrU, CrBl and CrEry were measured by means of graphite furnace atom absorption spectrometry. Linear regression models were applied to model exposure to chromium. A multiple imputation approach was chosen to account for values below the limit of quantitation (LOQ).

Results Median concentrations of CrR were $<3.80 \text{ g/m}^3$, with about 23% below LOQ. Major determinants of the CrR were the chromium content in the electrodes or base material in addition to the type of welding. Airborne exposure was higher when welding was performed under inefficient ventilation. CrR correlated strongly with CrU (Pearson's correlation $r = 0.61$). Median concentrations of CrU were $<1.20 \text{ g/m}^3$, and 44% of CrU measurements were below LOQ. CrU exposure decreased by a factor of 0.66 when a respiratory mask was used. Most measurements of CrBl and CrEry were below LOQ. All 15 welders with a measurable concentration of CrEry had high chromium contents in the materials (above 5%).

Conclusions CrR was mainly influenced by the chromium content in the materials and the welding process. Welding in confined space increased exposure to CrR. Efficient local exhaust ventilation and the use of respirators decreased exposure. Airborne Cr concentration was a good predictor of urinary Cr exposure.

236 AIR MEASUREMENTS OF BENZENE AND OTHER ORGANIC COMPOUNDS IN THE NORWEGIAN PETROLEUM INDUSTRY 2007–2009: A REVIEW OF INDUSTRIAL HYGIENE REPORTS

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Objective Description of current exposure levels of benzene and other organic compounds among workers in the petroleum industry.

Materials A total of 2578 air measurements taken by 12 oil- and service companies were evaluated and summarised in a database. The data includes personal full-shift samples and measurements on specific tasks.

Results Most samples were from offshore installations (70%). 93 chemical agents were detected in the samples. Of these, 11 agents were measured in 100 or more samples including aromatic hydrocarbons (benzene $n = 853$, toluene $n = 1014$, xylene isomers $n = 987$, and ethylbenzene $n = 939$) and alkanes (n -hexane $n = 856$, oil vapour $n = 130$, oil mist $n = 132$). 66% of the chemical agents were measured in less than 11 samples. In total, 299 work tasks were described in the reports.

Generally, personal exposure levels of full-shift samples of benzene (median = 0.005 ppm), toluene (median = 0.005 ppm), ethylbenzene (median = 0.001 ppm), xylene (all isomers) (median = 0.005), and n -hexane (median = 0.003) were low compared to Norwegian 12-hour time-weighted average occupational exposure limits of 0.6 ppm, 15 ppm, 3 ppm, 15 ppm, and 12 ppm, respectively.

The highest personal air levels were reported when performing tasks such as cleaning of tanks, opening of processing units, changing of filters, and sampling from the petroleum stream.

Conclusion Although much of the monitoring data has been conducted for control evaluation and compliance, they provide a basis for industrial hygienists and exposure assessors to identify work tasks and jobs where exposures are likely, and provide an overview of current exposure levels. This work also shows that for most agents the exposure data is extremely sparse and therefore there is a need to measure chemical exposures in this industry.

237 THE WHAT-ME STUDY: RELATIONSHIPS BETWEEN WORK PRACTICES AND URINARY METAL CONCENTRATIONS AMONG WOMEN WORKING IN NON-TRADITIONAL TRADES

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Objectives The WHAT-ME cohort is a prospective study of reproductive health among Canadian women in non-traditional trades. The goal of this sub-study was to investigate associations between the exposure questionnaire and urinary metal concentrations.

Methods Women registered in welding, boilermaking, steam fitting/pipefitting ('welders') or electrical trade apprenticeships since 2005 were invited to join the cohort. Participants in the Alberta sub-study mailed-in a urine sample at 6 months. Correlations between urinary metals (by ICP MS) were investigated and principal components extracted. Relationships between individual metals, component scores and work practices (from exposure questionnaires at 6 months) were investigated.

Results 183 urine samples were collected. Analysis was limited to 108 subjects (57 welders, 51 electricians) who had completed trade-specific work since enrolment. Smokers (38%) had significantly higher urinary concentrations of cadmium, cobalt and lead. Metal concentrations were more strongly correlated in welders than electricians. In welders, the first principal component explained 46% of the variability in metal concentrations but for electricians only 23%. Geometric mean of each of the 12 metals measured was higher for welders than electricians: only chromium reached significance (0.51 vs. 0.16 $\mu\text{g/g-creatinine}$, $p < 0.001$). Among welders, tungsten inert gas (TIG) welders tended to have lower metal concentrations while those doing manual metal arc welding had significantly higher zinc concentrations ($p < 0.05$). Preliminary analyses of work practices suggest that both personal protective equipment and local exhaust ventilation were related to urinary metal concentrations; supplementary analyses will also include data on consumables and base metals.

Conclusions Urinary metal concentrations tended to be higher and more strongly correlated among welders compared with electricians. Welding tasks, materials and controls associated with urinary metal concentrations will guide strategies for exposure reduction in the welding trade.

238 STATISTICAL MODELLING OF PM10 AND PM2.5 EXPOSURES IN POULTRY BARNS, AND EVALUATION OF ELECTROSTATIC PRECIPITATORS TO CONTROL PARTICULATE EMISSIONS

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Objectives Particulate concentrations within poultry barns pose a potential occupational and environmental health concern. We